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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the resin lining steel pipe which was manufactured by the efficient method and in which the adhesion of a steel pipe and a resin lining layer was excellent especially about the inner surface resin lining steel pipe used for piping, such as feed water, hot water supply, air conditioning, and wastewater, etc.

[0002]

[Description of the Prior Art]Conventionally piping used for water works etc. for an improvement of corrosion resistance etc. inside, It is known that the lined resin lining steel pipe is used for the steel pipe in which vinyl chloride resin, a polyethylene resin granular material, etc. were given to surface treatments, such as a steel pipe or chromate treatment, galvanizing treatment, and priming.

[0003]However, when manufacturing these inner surface resin lining steel pipes, the method of forming a lining layer has been used for the steel pipe inner face by carrying out powder coating to the steel pipe which heated resin powder. This powder coating method had the expensive device, and it was difficult for it to make resin powder weld to a steel pipe inner face uniformly, and since it was easy to generate a pinhole etc., when it was used as a city water pipe etc. in the long run, there was a problem of performances of a product – anti-corrosiveness falls.

[0004]In order to solve the above-mentioned problem, poly norbornene, a styrene butadiene copolymer, Or it uses shape memory nature resin, such as transformer polyisoprene, shape stability is given to polyethylene resin, the pipe whose diameter was reduced smaller than the inside diameter of a steel pipe is inserted in a steel pipe, and the method of performing inner surface lining is indicated by [ the ] carrying out afterbaking restoration and sticking on a steel pipe inner face.

[0005]

[Problem(s) to be Solved by the Invention]However, the resin which has shape memory nature has expensive itself, and there was a problem in a moldability, chemical resistance, health nature, etc. What used polyethylene resin etc. as the base had a glass transition temperature as low as below ordinary temperature, and since it was in a rubber elasticity field in ordinary temperature, even if it reduced the diameter of a pipe, relaxation took place gradually, and it had the difficulty of becoming what has small stability soon. Although the method of giving shape stability by blending polyethylene resin with which the melting point is different as a method of furthermore giving shape stability to polyethylene resin was indicated, there was a problem of being hard to line a restoration temperature requirement when restoring shape small. In itself, since it did not have an adhesive property with a steel pipe but was very hard to paste up also to various adhesives, polyethylene resin was quite difficult for holding secondary first stage and adhesion performance, when lined in the inner surface of a steel pipe. When vinyl chloride resin was made into a lining layer, there were problems, such as shock resistance.

[0006]

[Means for Solving the Problem]In order to solve the above-mentioned problem, as a result of inquiring wholeheartedly, this invention persons, It consists of ionomer resin, ethylene and a copolymer which has an methacrylic acid component especially at least, or ethylene and a copolymer which has an acrylic acid ingredient at least. The efficient lining method which could solve various problems because a part or all of a carboxyl group that is contained in resin uses what is a salt with a metal ion as resin for inner surface lining, and used shape stability found out becoming applicable.

[0007]Especially Maleic anhydride modified polyolefin resin, ethylene maleic anhydride copolymerization resin, An ethylene maleic anhydride-acrylic ester copolymer, an ethylene-methacrylic acid copolymer, By providing a glue line which consists of an ethylene-acrylic acid copolymer or an ethylene-vinylacetate copolymer between a steel pipe and a lining resin layer, It found out that adhesive strength with a steel pipe was good, there was no exfoliation of an inner surface lining resin layer at an operating environment, and a powerful inner surface resin lining steel pipe could be manufactured.

[0008]Such an inner surface resin lining steel pipe inserts in a steel pipe beforehand diameter reduction or an ionomer resin pipe which was folded up and made smaller than an inside diameter of a steel pipe, and can manufacture it efficiently by carrying out heating expansion and sticking this resin pipe on a steel pipe inner face after that.

[0009]Although it is not clearly clear about a reason an inner surface resin lining steel pipe of this invention has good performance, it is guessed as follows.

[0010]Ionomer resin is a functional group which a polymer molecule has, and resin which has

the ion bridge construction by a metal ion contained in resin. Thus, as a result of there being ion bridge construction, the portion serves as a restricting point of a certain kind, and it is thought that it is useful to reveal shape stability where it was stabilized. That is, also in processes, such as diameter reduction, unlike many of other crystalline polymer, necking is not caused but the diameter of the whole is reduced uniformly. When carrying out shape restoration, temperature up is carried out, but as a result of becoming large, a difference, i.e., a restoration temperature requirement, with temperature temperature and resin which shape restoration reveals become soft and fuse in that case, and it becomes impossible to hold shape, it is thought that stable shape restoration comes to be obtained.

[0011] Many portions with polarity are in resin, and as a result of this considering interactions, such as electrostatic attraction, as polar groups, such as a hydroxyl group on the surface of a primer layer on a steel pipe or a steel pipe, it seems that adhesion will become good. It becomes possible by especially various adhesives', such as a heat-hardened type's and a hot melt type's, having many polar portions, and putting in a glue line also to an ionomer, since familiarity is good to obtain a firm inner surface resin lining steel pipe of adhesion.

[0012]

[Embodiment of the Invention] The ionomer resin used by this invention is resin with the structure which constructed the bridge with the metal ion in between the molecules of resin, and its copolymer which has an ethylene ingredient, an methacrylic acid component or an ethylene ingredient, and an acrylic acid ingredient at least especially is preferred. the content of these ingredients -- more than 30 mol % -- the thing beyond 70 mol % is preferably good, and 100%, i.e., an ethylene-methacrylic acid copolymer, and especially an ethylene-acrylic acid copolymer are preferred. As an example of a third component, acrylic ester, methacrylic acid ester, vinyl acetate, propylene, butene-1, a maleic anhydride, etc. can be mentioned. The carboxyl group contained in resin has more than 1 mol % and the good thing from which more than 10 mol % is a salt with a metal ion preferably. A metaled kind is not limited to this, although zinc, sodium, magnesium, lithium, potassium, calcium, etc. are raised. The density of more than  $0.93 \text{ g/cm}^3$  is [ more than  $0.87 \text{ g/cm}^3$  / below  $0.99 \text{ g/cm}^3$  ] below  $0.97 \text{ g/cm}^3$  preferably, and 70 \*\* - 150 \*\* of melting points are 85 \*\* - 120 \*\* still more preferably preferably. 0.01g/10 minutes or more 20g/10 minutes or less of MFRs are 0.1g/10 minutes or more 10g/10 minutes or less still more preferably. Additive agents, such as an antioxidant, an ultraviolet ray absorbent, fire retardant, paints, a bulking agent, lubricant, and a spray for preventing static electricity, can be added to the ionomer resin used by this invention in the range which does not spoil the performance of this invention if needed.

[0013] As adhesives, maleic anhydride modified polyolefin resin, ethylene maleic anhydride copolymerization resin, What consists of the ethylene maleic anhydride-acrylic ester copolymer, the ethylene-methacrylic acid copolymer, an ethylene-acrylic acid copolymer, or an

ethylene-vinylacetate copolymer is preferred. In the range which does not spoil the performance of this invention, additive agents, such as an antioxidant, an ultraviolet ray absorbent, fire retardant, paints, a bulking agent, lubricant, a spray for preventing static electricity, and a tackifier, can be added if needed.

[0014]The ionomer resin pipe which has the shape stability used by this invention is produced using the above-mentioned ionomer resin. When extruding resin from an extruder to pipe shape with a circular screwing die and taking over the extruded resin as a manufacturing method, extension and after that, it cools in the direction of a pipe stem, and shape is fixed to it. Or the once fabricated pipe can be put into oven, a microwave oven, a high-frequency-induction-heating furnace, etc., and more than softening temperature can use the method of raising, extending and reducing the diameter of temperature below to the melting point.

[0015]The ionomer resin pipe used by this invention can have a glue line outside. Or it extrudes a glue line simultaneously for a bilayer dice, it is producible by lining for a circular screwing die and T dice outside after pipe production, or twisting around a resin pipe outside surface the glue line which carried out extrusion molding to the sheet shaped etc.

[0016]Thickness, such as an inner surface lining resin layer and a glue line, can be set up arbitrarily if needed, Although not restricted in particular, as an inner surface lining resin layer, 0.01 mm or more 1.5 mm or less is usually preferably used 0.003 mm or more 3 mm or less 0.3 mm or more 10 mm or less as 0.5-mm or more 5 mm or less and a glue line.

[0017]Plating treatment etc. could be performed to the surface, if needed, blast processing, pickling treatment, etc. can be pretreated on an inner surface or an outside surface, and the steel pipe used by this invention can perform surface treatments, such as chemical conversion and priming, to a pan. The size of a steel pipe uses that whose outer diameter is usually about 20-170 mm about 10-2000 mm.

[0018]As a manufacturing method of the inner surface lining steel pipe of this invention, a resin pipe with a beforehand bigger outer diameter than the inside diameter of a steel pipe is extruded, the diameter of it is reduced, and it is made a pipe smaller than the inside diameter of a steel pipe. This is inserted into a steel pipe and it heats with high frequency induction heating, a hot blast stove, etc., and shape restoration of the resin pipe is carried out, and there is a method of sticking and manufacturing to a steel pipe inner face.

[0019]As a manufacturing method of the ionomer resin pipe of this invention, ionomer resin is extruded from a circular screwing die at 90-250 \*\*, and it extrudes in that case, and from the diameter of a dice, it extends to a longitudinal direction so that the path of a pipe may become small 5 to 40%, and it cools with water cooling, air cooling, etc. after that, and shape is fixed. Before applying enlargement, it may cool if needed and resin may be cooled to a suitable temperature. The pipe fabricated without once applying extension can be heated in oven to 50-150 \*\*, and the method of extending and cooling to a longitudinal direction and fixing shape so

that a pipe diameter may become small 5 to 40% can also be used.

[0020]As a lining method of the resin lining steel pipe of this invention, First, after pretreatment of blast processing, pickling, etc. inside if needed further. From the steel pipe inside diameter manufactured with the described method, about 0.1 to 50%, it has a desirable outer diameter small about 0.3 to 20% in the steel pipe which performed surface treatments, such as chemical conversion and primer coating, and an ionomer resin pipe still longer 5 to 30% than the length of a steel pipe is inserted in it. A steel pipe is heated so that steel pipe surface temperature may be 100-250 °C with a high frequency heating device or a hot blast stove. The ionomer resin pipe inside a steel pipe is heated by the heat transfer from a steel pipe, or a hot wind, and by it, the power which carries out shape restoration works in the shape before extension, and it sticks to a steel pipe inner face. After cooling, the resin pipe protruded from the steel pipe end part is cut, and an inner surface resin lining steel pipe is obtained.

[0021]

[Example][Examples 1-8] Ionomer resin of Table 1 was extruded to pipe shape with an outer diameter of 30.0 mm with the die temperature of 180 °C. After pipe surface temperature was cooled to 80 °C, the pipe was extended until the outer diameter was set to 26.1 mm, and the with cooling, the outer diameter of 26.1 mm, and a thickness of about 1.5 mm pipe was further produced with the cooling water pool.

[0022]The with a 4 m 50 cm length produced with the described method ionomer resin pipe was fitted over the inside of the steel pipe (inside diameter 27.6mmphi, phi4 m with an outer diameter of 34 mm) which carried out blast processing. Then, it heated until the temperature of the steel pipe surface became 200 °C with the high frequency heating device, and shape restoration of the ionomer resin pipe was carried out. The resin part protruded from the steel pipe end part was cut.

[0023]

[Table 1]

実施例	タ イ プ		密 度 g/cm <sup>3</sup>	MFR g/10min	融 点 °C
	ベ ー ス 樹 脂	金 属			
1	エチレン-メタクリル酸共重合体	ナトリウム	0.940	10	95
2	エチレン-メタクリル酸共重合体	ナトリウム	0.940	12	97
3	エチレン-メタクリル酸共重合体	亜鉛	0.940	50	98
4	エチレン-メタクリル酸共重合体	亜鉛	0.960	99	88
5	エチレン-メタクリル酸共重合体	亜鉛	0.960	10	86
6	エチレン-メタクリル酸共重合体	マグネシウム	0.935	12	83
7	エチレン-アクリル酸共重合体	ナトリウム	0.965	8	99
8	エチレン-アクリル酸共重合体	マグネシウム	0.933	15	83

[0024][Examples 11-18] Although the resin pipe was fabricated using ionomer resin of Example 2, resin of Table 2 was used, the two-layer dice was used on that occasion, and the glue line of about 0.1-mm thickness was formed in the outside surface of an ionomer resin pipe at it. The inner surface resin lining steel pipe was manufactured like Example 1 except it.

[0025]

[Table 2]

実施例	タ イ プ	密 度 g/cm <sup>3</sup>	MFR g/10min	融 点 °C
11	エチレン-アクリル酸 (12wt%) 共重合体	0.940	8	94
12	エチレン-アクリル酸 (7 wt%) 共重合体	0.930	8	103
13	エチレン-メタクリル酸 (12wt%) 共重合体	0.940	14	96
14	エチレン-メタクリル酸 (4 wt%) 共重合体	0.930	7	105
15	エチレン-酢酸ビニル (28wt%) 共重合体	0.95	6	165 [融点]
16	エチレン-無水マレイン酸 (2 wt%) - アクリル酸エチル (8 wt%) 共重合体	0.937	8	98
17	エチレン-無水マレイン酸共重合体 (3 wt%)	0.945	5	108
18	無水マレイン酸変性ポリエチレン	0.94	1	122

[0026][Example 21] Ionomer resin of Example 2 was extruded and water-cooled to pipe shape with an outer diameter of 30.0 mm with the die temperature of 180 \*\*, and mold goods were obtained. Temperature up was carried out until pipe surface temperature became 90 \*\* in oven after that, the pipe was extended and it cooled until the outer diameter was set to 26.1 mm after that, and the with the outer diameter of 26.1 mm and a thickness of about 1.5 mm pipe was produced.

[0027]The with a 4 m 50 cm length produced with the described method ionomer resin pipe was fitted over the inside of the steel pipe (inside diameter 27.6mmphi, phi4 m with an outer diameter of 34 mm) which carried out blast processing. Then, it heated until the temperature of the steel pipe surface became 200 \*\* with the high frequency heating device, and shape restoration of the ionomer resin pipe was carried out. The resin part protruded from the steel pipe end part was cut.

[0028][Comparative example 1] Density <sup>3</sup> of 0.94g/cm, MFR0.3g/10min, and high-density-polyethylene resin with a melting point of 126 \*\* were extruded to pipe shape with an outer diameter of 30.0 mm with the die temperature of 200 \*\*. After pipe surface temperature was cooled to 110 \*\*, the pipe was extended until the outer diameter was set to 26.1 mm, and the with cooling, the outer diameter of 26.1 mm, and a thickness of about 1.5 mm pipe was further produced with the cooling water pool.

[0029]The with a 4 m 50 cm length produced with the described method resin pipe was fitted over the inside of the steel pipe (inside diameter 27.6mmphi, phi4 m with an outer diameter of 34 mm) which carried out blast processing. Then, it heated until the temperature of the steel pipe surface became 200 \*\* with the high frequency heating device, and shape restoration of the resin pipe was carried out. The resin part protruded from the steel pipe end part was cut.

[0030][Comparative example 2] Density 0.930 g/cm<sup>3</sup>, MFR9g/10min, and ethylene-vinyl acetate (10wt%) copolymerization resin with a melting point of 96 \*\* were extruded to pipe shape with an outer diameter of 30.0 mm with the die temperature of 180 \*\*. After pipe surface

temperature was cooled to 80 \*\*, the pipe was extended until the outer diameter was set to 26.1 mm, and the with cooling, the outer diameter of 26.1 mm, and a thickness of about 1.5 mm pipe was further produced with the cooling water pool.

[0031]The with a 4 m 50 cm length produced with the described method resin pipe was fitted over the inside of the steel pipe (inside diameter 27.6mmphi, phi4 m with an outer diameter of 34 mm) which carried out blast processing. Then, it heated until the temperature of the steel pipe surface became 200 \*\* with the high frequency heating device, and shape restoration of the resin pipe was carried out. The resin part protruded from the steel pipe end part was cut.

[0032][Comparative example 3] Specific gravity 1.43 and rigid PVC of 83 \*\* of Vicat softening points were extruded to pipe shape with an outer diameter of 30.0 mm with the die temperature of 200 \*\*. Using the resin for glue lines used in Example 13, the two-layer dice was used on that occasion, and the glue line of about 0.8-mm thickness was formed in the outside surface of a vinyl chloride resin pipe at it. After pipe surface temperature was cooled to 120 \*\*, the pipe was extended until the outer diameter was set to 26.1 mm, and the with cooling, the outer diameter of 26.1 mm, and a thickness of about 1.5 mm pipe was further produced with the cooling water pool.

[0033]The with a 4 m 50 cm length produced with the described method resin pipe was fitted over the inside of the steel pipe (inside diameter 27.6mmphi, phi4 m with an outer diameter of 34 mm) which carried out blast processing. Then, it heated until the temperature of the steel pipe surface became 200 \*\* with the high frequency heating device, and shape restoration of the resin pipe was carried out. The resin part protruded from the steel pipe end part was cut.

[0034]About the inner surface resin lining steel pipe produced by Examples 1-21 and the comparative examples 1-3, the lining state was observed and measurement of the adhesive strength of a lining layer and a shock-proof examination were done. About the lining state, shape restoration was insufficient, or lining resin became soft, and that whose lining was not completed in the good state was made into rejection (x).

[0035]Shear adhesive strength measurement : the measuring method of shear adhesive strength, The resin lining steel pipe manufactured on condition of the above-mentioned is cut to 20-mm length, only an outside steel pipe section is supported using a jig, pushing only an inside lining layer was kept on condition of 50 mm/min, it kept pushing at this time, power was made into shear adhesive strength, and it was regarded as adhesive strength. The sample asked for five-piece each picking, the maximum, the minimum, and an average. The unit of adhesive strength is kgf/cm<sup>2</sup>. The temperature under measurement test was 23 \*\* uniformly.

[0036]Cold shock-proof nature : The test method of cold shock-proof nature neglects a resin lining steel pipe at the place of 0 \*\* of ambient temperature, After checking that the inner surface of the resin lining steel pipe had become 0 \*\*, 15 kg of falling weight was dropped from a height of 2.5 m on the resin lining steel pipe, and the lining layer of the inner surface made

the destroyed things, such as exfoliation and a crack, rejection (x).

[0037]A result is shown in Table 3.

[0038]

[Table 3]

例	ライニング状態	接着力 (kgf/cm <sup>2</sup> )			耐低温衝撃性
		最 大	最 小	平 均	
実施例 1	○	58	50	53	○
実施例 2	○	56	48	52	○
実施例 3	○	62	52	58	○
実施例 4	○	65	50	58	○
実施例 5	○	63	53	57	○
実施例 6	○	58	40	50	○
実施例 7	○	53	50	52	○
実施例 8	○	56	41	48	○
実施例 11	○	110	95	102	○
実施例 12	○	103	83	92	○
実施例 13	○	102	77	90	○
実施例 14	○	95	72	81	○
実施例 15	○	69	41	51	○
実施例 16	○	73	53	65	○
実施例 17	○	78	52	68	○
実施例 18	○	103	65	81	○
実施例 21	○	58	48	53	○
比較例 1	×	—	—	—	—
比較例 2	×	—	—	—	—
比較例 3	○	61	41	52	×

[0039]

[Effect of the Invention] Since it can manufacture by the efficient method using shape restoration, and the adhesive strength of a lining layer and a steel pipe is high, and is excellent in shock resistance and it has sufficient anti-corrosiveness, the inner surface resin lining steel pipe of this invention can be used as a service pipe which can fully be satisfied.

[Translation done.]